

Development Support Group

E. B. Jackson and A. L. Price
RF Systems Development Section

The activities of the Development Support Group in operating the Venus Deep Space Station (DSS 13) and the Microwave Test Facility (MTF) for the period October 16 through December 15, 1972, are presented and categorized by facility and section supported. Major activities include an extensive test program of dual uplink carrier generation and measurement of intermodulation products in the downlink band resulting therefrom. A description of the progress of this test program, along with work required to minimize production of intermodulation products, is given. Progress in precision antenna gain measurements, continuing planetary radar experiments, and weak source observations are other activities noted.

During the two months ending December 15, 1972, the Development Support Group was engaged in the following activities.

I. DSS 13 Activities

A. In Support of the Communications Systems Research Section

1. Pulsars. The routine observation of pulsars was interrupted by requirements of the Dual-Carrier Project, but a total of 38 hours of observations was made.

2. Planetary radar. Continuing support of the Mariner Venus/Mercury 1973 (MVM 73) spacecraft mission, ranging measurements to the planet Mercury have been regularly made. These measurements are made using the

64-m-diameter antenna and the 400-kW transmitter at DSS 14 for transmission and reception, with pseudonoise code generation, data processing, and control being performed at DSS 13. Ranging measurements with a resolution of 5 μ s were made of Mercury for a total of 66 good signal runs during this period.

B. In Support of the Communications Elements Research Section

1. Precision antenna gain measurement. Radio sources 3C123 and Virgo A were used as calibration sources from which data were obtained to calculate the absolute gain of the 26-m-diameter antenna. A total of 56 hours was devoted to these measurements using the SDS-930 computer to do automatic boresighting and tracking of the radio sources.

2. Weak source observation. Measurements were made for a total of 33 hours on radio sources 3C123, 3C348, 3C353, Cygnus X3, and the planet Jupiter. An additional 55 hours were spent on sky survey measurements with the antenna in a fixed position. Data taking is automated using the SDS-910 computer for antenna pointing and boresighting and an HP 5360A computing counter for control, measurement, and data recording.

3. Side lobe pattern (26-m antenna). Continuing the measurement of the magnitude and location of the side lobe pattern responses of the 26-m-diameter antenna, the ALSEPs left on the moon by Apollo missions are used as a calibration source across which the antenna is scanned in a raster scan with the output signal level being automatically recorded by the computer. Results have been very good and additional data will be taken with the quadripod legs on the antenna covered. These "before and after" data sets will be compared to see if significant reduction in side lobe response can be achieved by covering the quadripod legs. A total of 91 hours of tracking was obtained during this reporting period.

C. In Support of the RF Systems Development Section

1. Acceptance testing of 400-kW klystrons. A repaired 400-kW, 2115-MHz klystron (X3075) was received from Varian Associates and has undergone acceptance testing at the High Power Test Area at DSS 13. The initial tests revealed a possible problem with excessive outgassing in the tube and further tests were performed. However, an additional 2 days of testing were successful in "pumping down" the tube and it now meets all acceptance criteria.

2. Dual uplink carrier testing. Evaluation of the intermodulation products (IMPs) present in the downlink as a result of dual uplink carriers being transmitted by a single transmitter klystron has continued. An intensive program of elimination of possible noise producing sources, e.g., welding of all bolted joints above the dish surface, removal of all unshielded cables and wires, and careful taping of the antenna panel joints, resulted in a reduction of the intermodulation product levels to approximately -145 dBm. However, testing out the sidelooking feedhorn, which does not utilize the subreflector or main reflector, demonstrated intermodulation product levels of approximately -175 dBm.

To isolate further IMP producing elements, the quadripod and subreflector were removed, the waveguide sys-

tem, polarizer, feedhorn, and waveguide switches were disassembled and carefully cleaned in nitric acid, and the system reassembled and tested. Although a further reduction in IMP levels was noted, it was determined that radio frequency currents on the outside of the feedhorn were still generating IMPs and noise.

A different feedcone, with all-welded exterior seams and structure, containing the feedhorn previously used as the sidelooking feedhorn (which is of a new design and has minimum exterior currents at 2115 MHz), a minimum amount of waveguide, and no switches, was installed onto the antenna in place of the existing feedcone. This simplification of the feedcone required the 2295/30-MHz converter to be removed from the S-Band Radar Operational (SRO) feedcone and temporarily installed in the 26-m-diameter antenna electronics room. Only a minimum receiving system instrumentation system is provided, and a measurement of maser gain requires physical changeover of cabling in the electronics room. If adjustment of maser gain and bandwidth is required, additional test equipment must be moved into the electronics room to substitute for the equipment that was not transferred from the SRO feedcone.

Testing with this new feedcone, without the quadripod, produced acceptable IMP-level performance and the quadripod and subreflector were reinstalled for further testing. Prior to reinstallation, the "spillover reduction" skirt around the subreflector was welded to the subreflector, and the vertex plate (in the center of the subreflector) was welded to prevent, insofar as possible, any noise production by arcing between different radio frequency potentials. Intermodulation product levels with this configuration are now -165 dBm, with further testing scheduled.

The Block II maser, utilized in all measurements of IMP levels in the downlink band, has performed without fault since original cooldown and tuning on October 12, 1972. However, the spare Block II maser was found to be unusable because of an inability to maintain a vacuum in the refrigerator jacket. Replacement of the refrigerator ion pump corrected this problem, but the associated helium compressor required overhaul before proper operation was obtained. After again starting testing of the spare maser, after ion pump replacement, the oil pump in the compressor failed and required replacement. However, the spare maser refrigerator and spare helium compressor have been tested, the refrigerator successfully

cooled to liquid helium temperature, and these items are now fully functional.

3. Clock synchronization transmitter. Periodic testing of the 100-kW X-band transmitter has continued. This is required to maintain the transmitter in operational condition and also to protect the transmitter during cold weather.

A new nitrogen (N_2) manifold is being installed at the 9-m-diameter antenna to enable operation of the transmitter from one (N_2) pressure source instead of the three previously required. The manifold will also provide a "loss of pressure" alarm. Work is also underway to weather-proof the electronics room on the 9-m-diameter antenna. At the present time, whenever the antenna is at zenith and it rains, most of the water caught in the dish is funneled along the waveguide run into the electronics room. Until this work is completed, storing the antenna at about 60 deg elevation serves to keep most of the water out of the electronics room.

D. In Support of the DSIF Operations Section

1. Clock synchronization transmissions. Although routine transmission of clock synchronization signals has ceased, three transmissions were made to DSS 41 in support of a Mariner 9 spacecraft experiment, and one transmission was made to DSS 42 at their request. Periodic testing, as described earlier, also continues.

II. Microwave Test Facility (MTF) Activities In Support of the RF Systems Development Section

During this reporting period, the primary activity has been supporting the Dual Uplink Carrier and associated transmitter testing. The disassembly, cleaning, and reassembly of the SRO feedcone was performed by MTF personnel, who also lapped all waveguide, polarizer, and feedcone joints as well as fabricated special stainless steel hardware required for reinstallation.